

# Electrocardiogram Experiment

## using latin square design

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## 1 Introduction

## 2 Design and the Data

## 3 Analysis

## 4 Related Contents

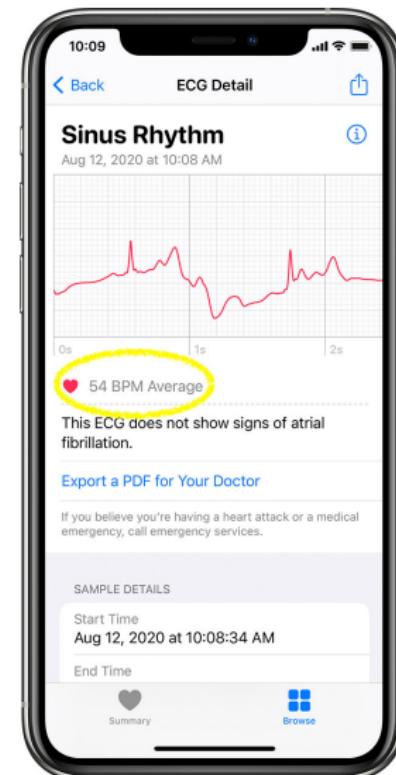
## Section 1

### Introduction

# Electrocardiogram Experiment

## Goal

- Does caffeine affect ECG or *heart rate*?
- Caffeine: *coffee*
- Output: Average heart rate (BPM)



# Latin Square Design

Table 1: Reduced Latin Square

Row	Column			
	1	2	3	4
1	A	B	C	D
2	B	C	D	A
3	C	D	A	B
4	D	A	B	A

- Each treatment once in each row and column
- We allocate 4 treatment levels randomly

## Section 2

Design and the Data

# Blocking Factors

Caffeine intake depends on the following two factors (한동하, 2018).

Row: Coffee-to-water ratio

- ① 1:0 (Espresso, 40 ml)
- ② 1:2.5 (Water 100 ml)
- ③ 1:5 (Water 200 ml)
- ④ 1:7.5 (Water 300 ml)

Column: Drinking speed

- ①  $\leq 5$  sec
- ② 5-15 sec
- ③ 15-30 sec
- ④  $30 <$  sec



# Factor

Intake of caffeine (himynameisabcde, 2020) from Starbucks by Nespresso

- ① House blend: 74.5 mg
- ② Sumatra: 54.5 mg
- ③ Decaf espresso roast: 3 mg
- ④ Just water: 0 mg

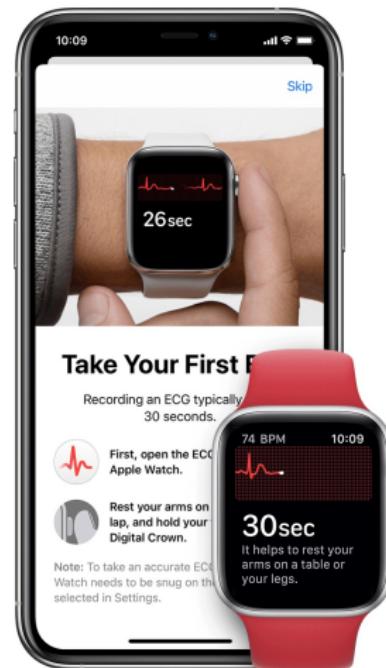
# Output

## Value: Average heart rage

- in BPM
- Notations from the course  
(Lee, 2021)

## Measure

- Apple Watch Series 4
- watchOS 7.3.3 (1.18S830)
- ECG app
- Algorithm version: 1



# Randomized Assignment

- ① Randomly allocate (1, 2, 3, 4) to previous (A, B, C, D)
- ② Assign to above Table 1

```
set.seed(1)
sample(LETTERS[1:4])
#> [1] "A" "C" "D" "B"
```

- Ⓐ House blend (74.5 mg)
- Ⓑ Water (0 mg)
- Ⓒ Sumatra (54.5 mg)
- Ⓓ Decaf espresso roast (3 mg)

# Latin Square

Table 2: Design of the Experiment

Water	Drinking Speed			
	<=5	5-15	15-30	30<
0 ml	H(74.5)	W(0)	S(54.5)	D(3)
100 ml	W(0)	S(54.5)	D(3)	H(74.5)
200 ml	S(54.5)	D(3)	H(74.5)	W(0)
300 ml	D(3)	H(74.5)	W(0)	H(74.5)

<sup>1</sup> 'Water' is the coffee-to-water ratio (divide with 40 ml)

<sup>2</sup> Numbers in the brackets indicate caffeine (in mg)

- Use *reduced latin square*
- Randomization test afterward

# Controlling the Other Variables

## Coffee

- Drink coffee every morning
- before eating breakfast
- Nespresso machine: Pixie C61 in my home

## Measure

- Sitting at the table
- Rest my arms on the table
- Use the same strip
  - Nike sport band
  - of same fit (8-th)
- and other instructions in  
<https://support.apple.com/en-us/HT208955>

## Section 3

Analysis

# Dataset

```
(ecg <- read_csv("../data/raw/ecg.csv"))
#> # A tibble: 16 x 6
#>   id     date    water speed coffee hr
#>   <dbl> <date>   <dbl> <dbl>  <dbl> <lgl>
#> 1 1 2021-04-21     1     1      1 NA
#> 2 2 2021-04-22     1     2      4 NA
#> 3 3 2021-04-23     1     3      2 NA
#> 4 4 2021-04-24     1     4      3 NA
#> 5 5 2021-04-25     2     1      4 NA
#> 6 6 2021-04-26     2     2      2 NA
#> 7 7 2021-04-27     2     3      3 NA
#> 8 8 2021-04-28     2     4      1 NA
#> 9 9 2021-04-29     3     1      2 NA
#> 10 10 2021-04-30    3     2      3 NA
#> 11 11 2021-05-01    3     3      1 NA
#> 12 12 2021-05-02    3     4      4 NA
#> 13 13 2021-05-03    4     1      3 NA
#> 14 14 2021-05-04    4     2      1 NA
#> 15 15 2021-05-05    4     3      4 NA
#> 16 16 2021-05-06    4     4      2 NA
```

Introduction  
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Design and the Data  
○○○○○○○

Analysis  
○○●○○

Related Contents  
○○

References

# ANOVA

Introduction  
○○○

Design and the Data  
○○○○○○○

Analysis  
○○○●○

Related Contents  
○○

References

# Sharp Null

Introduction  
○○○

Design and the Data  
○○○○○○○

Analysis  
○○○●

Related Contents  
○○

References

# Randomization Test

## Section 4

Related Contents

# Project Repo

My Github project for this experiment:

<https://github.com/ygeunkim/ecg-experiment>

himynnameisabcde (2020). r/nespresso - i received the caffeine content numbers for starbucks nespresso pods!

[https://www.reddit.com/r/nespresso/comments/id31r5/i\\_recieved\\_the\\_caffeine\\_content\\_numbers\\_for/](https://www.reddit.com/r/nespresso/comments/id31r5/i_recieved_the_caffeine_content_numbers_for/).

Lee, K. (2021). Design and analysis of experiments (sta5031).  
<https://icampus.skku.edu>. Accessed: 2021-03-20.

한동하 (2018). [한동하 원장의 웰빙의 역설] 냉커피는 뜨거운 커피와 어떤 차이가 있을까?

<http://www.k-health.com/news/articleView.html?idxno=37375>.